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THE SOLAR AIRCRAFT

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16. Abstract A discussion is given in a popular manner of the solar powered aircraft Solair I. The achievements of the designer are detailed, and trial runs leading up to the first successful flight are given. Technical data of Solair I are listed, and brief news items about it are presented.			
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Solair I: The Answer for Alternative Flight

In December of last year, the 41-year old industrial designer from Munich, Guenter Rochelt provided us with a gigantic surprise. In Oberpfaffenhofen he succeeded in the first flight of the solar-powered aircraft Solair I.

Students in Japan, hobbyists in the Swabian hills, engineers in England and sail plane pilots in America all competed for the big prize--the Kremer prize--for the first successful man-powered flight over an English mile. But who ever believed in this kind of miracle in today's high-technology world? A sail plane pilot, and a very well-known one at that, named Paul McCready was the one who happened to become a participant in this competition. Here it was particularly important to counter the notion that a man would be in a position, even over long periods, to generate a constant output of at least 1.5 hp. Anyway, the calculations of prominent aerodynamicists and scientists gave this result.

Paul McCready, himself bearing a doctor's title and with the world's championship in soaring in 1956 under his belt, arrived indeed at somewhat different conclusions. Based on theories propounded by him, 0.3 hp would suffice for an aircraft specially developed for this purpose. McCready provided the proof with the Gossamer Condor, a canard design. /68/

One year later then he achieved the taking under attack of the Kremer Prize for the first man-powered flight over the Channel, which in the meantime had been re-endowed up to the sum of DM 360,000. Paul McCready developed his first record breaking aircraft further and gave it the striking name of Gossamer Albatross. In looking for a suitable pilot, he discovered a young bicycle racer,

* Numbers in margin indicate pagination in foreign text.

the then 26-year old Bryan Allen. On 12 June 1979, exactly 70 years after the memorable Channel crossing of Louis Bleriot, this trained sportsman pedaled the 36 km stretch over the waters linking England and the European continent in 2 hours and 40 minutes. What an achievement !

McCready's Solar Plans

To a public already used to superlatives, Paul McCready, Bryan Allen and the aircraft Gossamer Albatross were the sensation of the Paris Aero Salon. Indeed, it was even believed that the nature and technology of one of the last great puzzles had been solved. Meantime, the resourceful American sold his aircraft design to energy-conscious countrymen.

The subject of Energy did not leave McCready any peace. What was more natural than for him to give the same dedication to solar energy that he had been accustomed to give for decades as a sail plane flyer? A new test article, the Gossamer Penguin was built. Based on the old Albatross, McCready created a type of solar sail that he added to the test craft by simply setting it "on the roof". An ad in the paper "seeking slender young lady with flight experience" helped the famous sail planer to find the 32-year old aviatrix Janis Brown as a new partner. She weighed only 48 kilos. Anyway, Bryan Allen had meantime turned to powered flight, and in any case was no longer quite suited to requirements of the concept.

But Janice Brown had everything the project called for--a sensitivity for flying and low weight. She also had a good helping of ambition.

Paul McCready's second theory, that is, to fly an outwardly almost conventional aircraft exclusively with solar energy, which, using 30,000 solar cells, drives a 3-meter propeller 300 rpm by means of a 2.3 kW electric motor.

As already in the case of the Gossamer Albatross, the idea got a financial shot from the Du Pont Chemical Co. which viewed the new project, Solar Challenger, as a research project pregnant with publicity possibilities. After initial unsuccessful test flights in October of last year, the good-looking Janice succeeded a month later in completing the first flight lasting 22-minutes. The Solar Challenger, which produced a speed of 56 km/hr, gained 55 meters per minute in calm air, which corresponds to a climbing performance of 0.91 meters/second.

London to Paris with Solar Power ?

McCready's next goal is a solar flight from London to Paris early this summer, a small surprise, as it were, for the participants in this year's World Soaring Championship in Paderborn.

But just as great a surprise awaited the 41-year old Munich industrial designer Guenter Rochelt on 17 December last year. The idea occurred to him in 1979, completely independently, to develop a solar-powered aircraft. Therefore, the newspaper hoax about the alleged first solar-powered flight by the fast-paced American promoter Larry Mauro hit him "like a hammer" recalled Rochelt from an interview at the time. Rochelt had already perceived the import of solar flying with his model solar-powered flight record of 3 hours and 41 minutes.

In contrast to McCready, Guenter Rochelt was almost exclusively dependent on his own resources and the assistance of close friends. The first important thing was to raise the sum of about DM 80,000, which he generated and administered by selling the outline of his ideas. No trifle for a head of family.

After flight activities with models lasting years, and with sail plane training taken earlier, he again underwent soaring instruction at the Unterwoessen Sail Plane School. Newly inspired by flight, his project very quickly took form. In this connection, Guenter Rochelt recalled the sensation-creating flights of the Swiss team of Farner and Ruppert on the Wasserkuppe in August of 1979. Hans Ulrich Farner had developed a canard aircraft with completely new technology, which is still hotly discussed to this day in specialist circles and which is gradually, for the first time, gaining entry into general construction, using synthetic materials.

The aircraft, which bears the name Canard--the Duck--had already been developed to production readiness, and in 1980 was to be delivered to further customers beyond the developmental run. However, a fatal crash put the brakes on the project until the fall of last year. Flight tests, first resumed again in November and December 1980, were able to prove pilot error at the time on the part of a professor at the Zurich Technical University who was killed in the accident. But Rochelt had been certain from the beginning that this was the concept to carry the solar drive.

Mr. Bucher, owner of the Swiss firm Canard Aviation, supported the Munich project by making available labor and the patterns for the original Canard. Next, a short experimental wing was created in which the technique of integrating the silicon solar cells into the wing profile had to be translated into practice. Simply fastening on the brittle silicon cells would have led to immediate stress cracks between the silicon substrate and the SFK (aramid fiber-reinforced plastic) on account of the difference in temperature coefficients. In contrast to

the GFK (glass fiber plastic) sailplanes we are familiar with, the Swiss Dipl. Ing. Farner had consistently employed for the first time the very strong aramid fibers produced by Du Pont under the name Kevlar. Now, construction with this compound was even more unresearched in its physical properties than the GFK structural method.

Energy Source: 2500 Solar Cells

Rochelt, earlier engaged by profession in pure design work, now was suddenly obliged to investigate physics and applied technology. His calculations yielded a requirement of about 2500 solar cells, which would have to supply a 1.8 kW electric motor with power. Starting with the, at that time, empty weight of Canard of 59 kilograms, lift-drag ratio of 31, and a minimum rate of descent of 0.8 m/sec, the German solar flight pioneer was of the opinion that reserves were still available.

In order to distribute the exactly 2499 solar cells on the wings of the Canard, there was now required an enlargement and alteration of the wing geometry. The wing span was brought up from 13.5m to 16m. In order to increase lift, the wing trailing edge was given additional slots. The forward wing, until now capable of being rotated about its long axis, was made rigid and controllability maintained, using a control surface for climb/descent control. Lateral control was taken over purely by the newly added winglets. The ailerons kept their function. /69/

The geometric enlargement and the associated weight increase made necessary purely external but very considerable rebuilding of the Canard.

Between the V-girder of the fuselage and the actual wings an additional pylon had to be introduced to increase strength and to accommodate the motor.

The First Flight Nears

With optimum solar radiation, the 2499 solar cells yield a nominal output of 2.2 kW. With this, the motor gets a potential of 88 volts. Despite this, the relatively good degree of efficiency of motor and transmission drive, as well as of the 2.65m propeller, yields a final shaft power of 1.5 kW.

Now, in complete quiet, Guenter Rochelt busied himself at the Canard Aviation plant in the Zurich forest to translate his plans into reality, and this almost unsuspecting of McCready's California project. The preliminary testing with the test wing showed that the silicon cells had to be embedded, floating in a silicon compound so that they are not destroyed by stresses in the airfoil. Moreover, the wing profile had to be protected, which led to a compromise. The flat cells were so fitted that no important alterations resulted; a special elastic foil was provided for the covering, and thereby the protection, of the solar cells.

The ostensibly so sensitive laminar profile, and particularly the Wortman profile FX 63-137, proved to be relatively insensitive and very well suited, despite the "tucks" in the surface. In putting together the actual flight article, 35,000 individual joints had to be made. On the day of the first flight, the 8-month rustication in the Swiss woods was suddenly forgotten by enthusiasts.

On 17 December, calculated as the most sun-poor month, everything was ready for the first flight at the plant airport of the DFVLR at Oberpfaffenhofen west of Munich. The Solair was pushed out of the hangar like a Phoenix rising. The solar cell-bedecked aircraft sparkled red-blue in the late winter sunshine. In the last months, everything had been minutely planned here; Rochelt would

have been able to carry out the first solar flight even before McCready, but during a test run, the carelessness of a DFVLR worker had led to damage to the propeller so that valuable time had been lost.

It is Accomplished: Rochelt is the First German Solar Flyer

The impatient television people and the few invited photographers stationed themselves with cameras on the west side of the runway. The usually very active flight test operations were shut down. Up to the last minute it was not yet quite clear who would make the first actual flight- Guenter Rochelt himself or the Ulm engineer and test pilot Klaus Juergen Richter, who himself had for some time since been flying a canard construction with great success. But Rochelt understandably then reserved to himself the triumph of the first flight.

His heart certainly must have beat very fast as he set the power switch by stages up to full power. The propeller turned at 360 rpm and accelerated the aircraft slowly until it took off after almost 200 meters. The noise was not much louder than a home vacuum cleaner; only the propeller made a light pulsating whistle. At 6m altitude, Rochelt throttled back the power and flew over almost the entire field. After a problem-free landing, he alighted rejoicing like a happy child and accepting congratulations; he was also a bit proud to have been at least the first solar flyer in Germany.

But McCready had now gotten a competitor for the Channel crossing who had to be taken very seriously, and it was a question as to for whom the sun would first shine over the Channel, for Rochelt's first flight had taken place partially

using a small booster battery. Further consequences could become milestones for the future of aviation. The beginning has been made, and one can only say: dear Lord, let the sun shine again on the solar flyers.

Technical Data: Solair I

Wing span	16m
Total wing area	22.32 m ²
Aspect ratio (main wings)	17
Length	5.4 m
Empty weight	200 kg
Stall speed	28 km/hr
Slowest sink rate	0.42 m/sec at 40 km/hr
Best lift/drag ratio	26 at 45 km/hr
Climbing rate	0.25 m/sec
Engine output	1.5 kW net
Motor	1.8 kW , 88 V nominal

BRIEF NEWS ITEMS

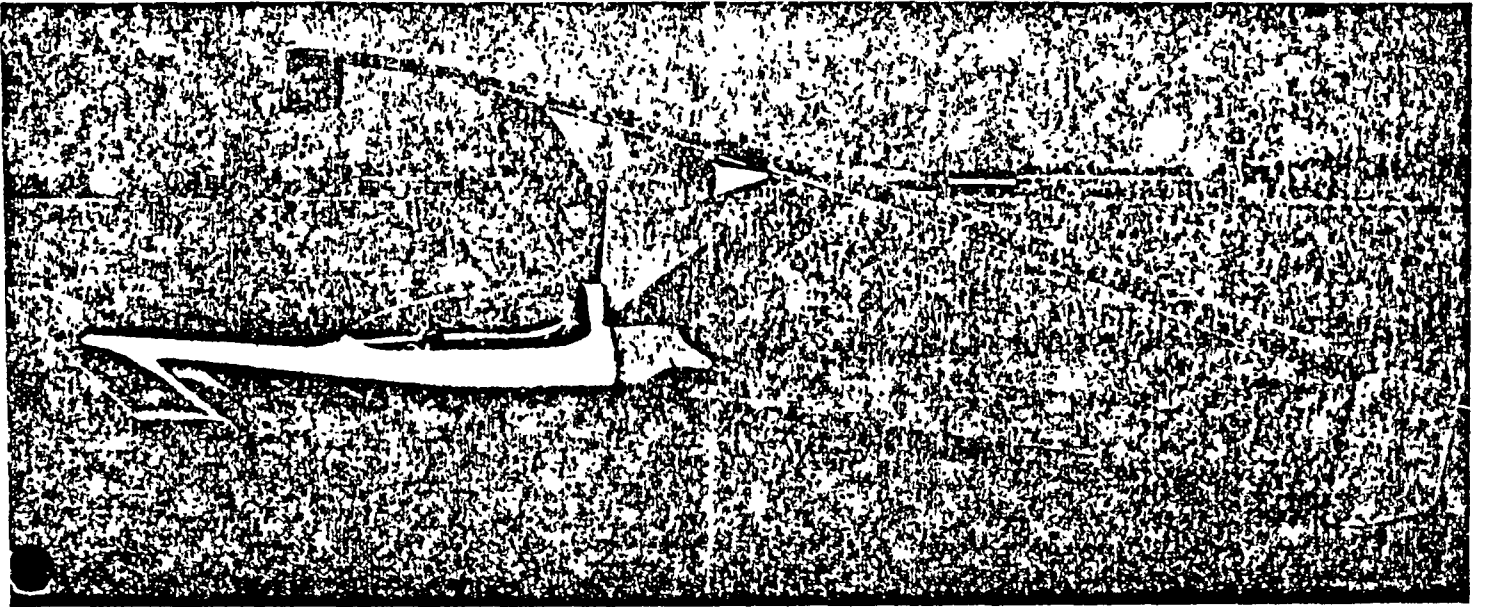
Rolladen-Schneider Announce the LS 6

At the German championships in 1982, Rolladen-Schneider wants to submit the successor of the LS-3, the LS-6, to a first public qualification test. The 15m, trailing-edge flap aircraft is said particularly to benefit from experiences with the LS-4 and is marked by a significantly smaller sensitivity of the profile to dirt.

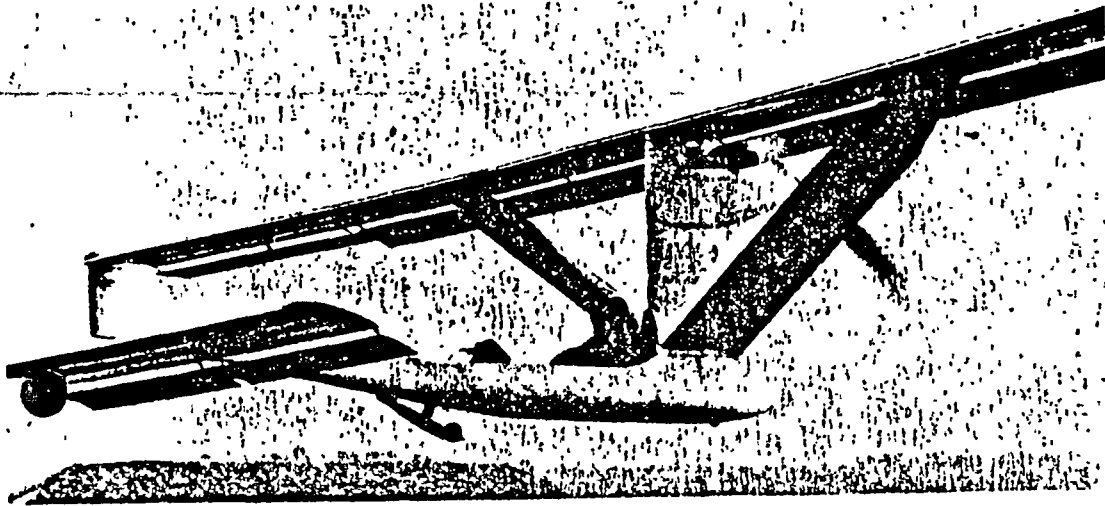
Series production is to begin at the end of 1982 for the LS-6, which also with a 17m wingspan is unrestrictedly flyable in the entire range of speed, flap and wing surface loadings.

DG 400 with CFK Airfoil

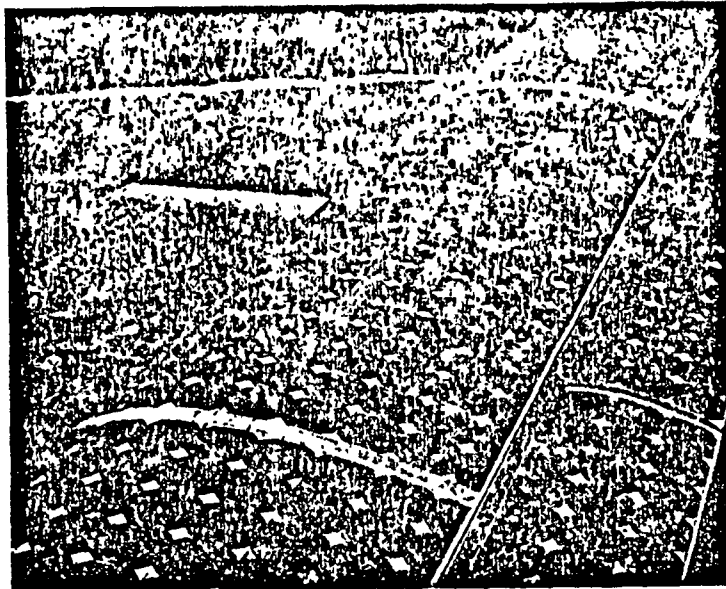
Alert readers will have immediately noticed it anyhow. The DG 400 (reported on in FR 2/81) has to have carbon fiber airfoils; otherwise, the weights would indeed be somewhat greater. A typo error let CFK become GFK. To make it quite precise: GFK means glass-fiber reinforced plastic, while CFK means carbon-fiber reinforced plastic.



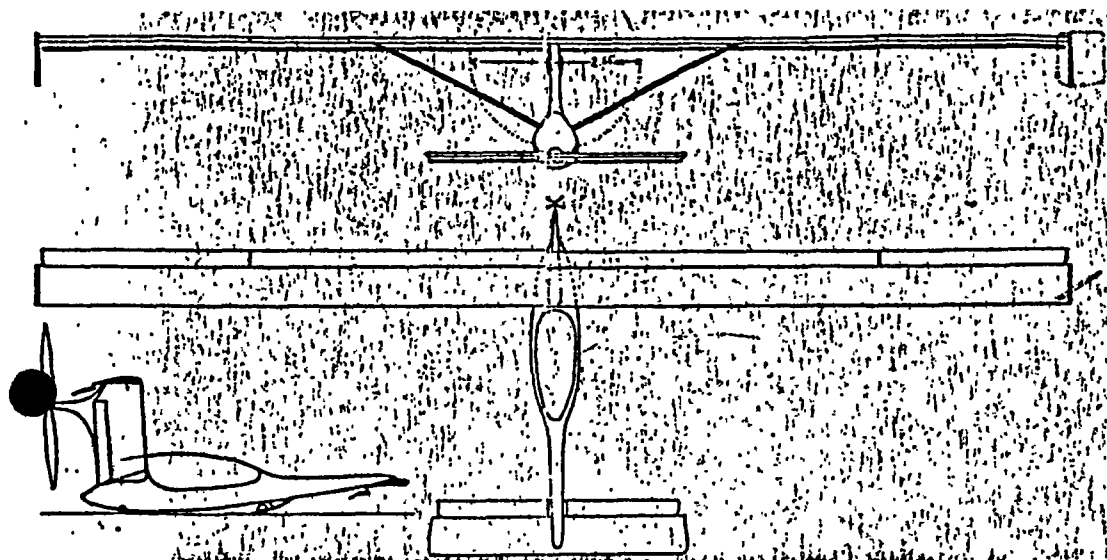
Based on the Swiss Canard Aircraft-Canard 2FL:
Guenter Rochelt's Solar-powered Solair I.



After a problem-free first flight: Guenter Rochelt is the
first German solar flyer



Around 2500 solar cells deliver the 2.2 kW nominal power



The unusual design of Solair I can be recognized in this three-view drawing.

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